

**A REVIEW OF THE HISTORY AND TAXONOMY OF
ECONOMICALLY IMPORTANT SERPENTINE LEAFMINERS
(*LIRIOMYZA* SPP.) IN CALIFORNIA
(DIPTERA: AGROMYZIDAE)**

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Liriomyza trifolii (Burgess) is a common serpentine leafminer on cut and pot chrysanthemums in California. This insect has recently become a serious threat to the chrysanthemum industry, presumably due to the development of resistance to many commercially registered insecticides. Research necessary to develop a pest management program for *L. trifolii* on chrysanthemums is currently in progress. Part of this research effort has involved a search of the literature for previous work done on other economically important members of the genus *Liriomyza* Mik. According to Spencer (1973), there are four species of economic importance in California: *L. brassicae* (Riley), *L. huidobrensis* (Blanchard), *L. sativae* Blanchard, and *L. trifoliarum* Spencer. A fifth can be added to this list, *L. trifolii*, which was introduced into California after 1973.

There has been considerable taxonomic confusion in the past with regard to the polyphagous Agromyzidae. This has been particularly true with members of the genus *Liriomyza*, due to their wide, overlapping host ranges and general morphological similarity. Although only five economically important *Liriomyza* spp. are currently recognized as occurring in California, the literature records 15 species. This is a result of numerous misidentifications and synonymies that have been determined since these early works. Spencer (1973) prepared the definitive work on the systematics of the Agromyzidae and in this he clarifies the present status of most of the California species. Steyskal (1973) summarized Spencer's clarification of the status of *Liriomyza* spp. in the United States and his list of species is identical to the list for California presented here.

This paper examines: (1) the taxonomic confusion that has occurred with the above five species in California including citations not covered by Spencer (1973); and (2) the host plants from which these species have been reared in California including recent surveys of economically important hosts for several of these flies completed in 1980. The purpose is to provide a concise chronological reference for researchers working with this important group of leafmining flies.

Liriomyza brassicae (Riley)

This species is the most cosmopolitan of all the Agromyzidae and occurs primarily on Cruciferae. There are limited records of *L. brassicae* in California. Oatman and Platner (1969) examined the population trends and parasitization of this species on cabbage in southern California. They concluded that *L. brassicae* was of minor economic importance.

Liriomyza huidobrensis (Blanchard)

Liriomyza huidobrensis, the pea leafminer (Sutherland, 1978), is Nearctic and Neotropical in distribution. This species was first cited in California as a pest of peas and spinach by Lange (1945) (as *L. orbona* (Meigen)). Subsequent work by Smith and Lange (1946) and Lange and Smith (1947) involved control of *L. huidobrensis* (as *L. orbona* (Meigen)) on peas. Lange (1949) discussed the occurrence of leafmining flies in California and stated that the species causing damage along the California coast, in coastal valleys and in areas having a coastal influence was *L. huidobrensis* (as *Agromyza* (*Liriomyza*) *flaveola* Fallén). This species was considered a pest of cruciferous crops, lettuce, melons, peas, sugar beets, tomatoes and cultivated flowers. In 1957, Lange et al. discussed *L. huidobrensis* (as *L. langei* Frick) as a serious pest of spinach. They indicated this species also attacked peas, peppers, lettuce, carrots, onions, asters, celery, beans, cineraria, zinnia, stock, guayule, cabbage, brussel sprouts, kohlrabi, cauliflower, turnip, broccoli, okra, parsnip, radish, dandelion, endive, chicory, and rutabagas.

Control measures for *L. huidobrensis* as a pest of asters were explored by Jefferson and Pence (1948) and Jefferson and Eads (1949) (as *L. flaveola* (Fallén)) and by Jefferson and Eads (1952) (as *L. langei* Frick).

Frick (1951) described a new species of serpentine leafminer, *L. langei*, from peas, sugar beets, spinach, celery and aster. Later, Frick (1958) described a new species of leafminer from carnation, *L. dianthi*, which he (Frick, 1964) synonymized with *L. langei*. *L. langei* was then synonymized with *L. huidobrensis* (Blanchard) by Spencer (1973).

Elmore and Ranney (1954) described the injury to seedling pepper plants by *L. huidobrensis* (as *L. langei* Frick), and Wilcox and Howland (1955) examined control measures for *L. huidobrensis* (as *L. langei* Frick) on sugar beets. Pritchard (1957) discussed a new leafmining pest of carnations (as *Liriomyza* sp.) which was probably *L. huidobrensis*.

During 1980, *L. huidobrensis* was reared from gypsophila grown in the San Diego area.

Liriomyza sativae Blanchard

Liriomyza sativae is Nearctic and Neotropical in distribution, occurring on a wide range of plants. In the San Joaquin and Sacramento Valleys Lange

(1949) indicated *L. sativae* (as *Agromyza (Liriomyza) subpusilla* Frost) was the most common species causing damage to alfalfa, beans, melons and tomatoes. In southern California, Lange (1949) found *L. sativae* (as *Agromyza (Liriomyza) pusilla* Meigen) damaging tomato.

Tilden (1950) reported on the oviposition and behavior of *L. sativae* (as *L. pusilla* (Meigen)) on *Baccharis pilularis* D.C. This reference indicates that larvae have the ability to leave one leaf and to enter another of the same host species.

Michelbacher et al. (1949, 1951, 1952, 1953, 1955) discussed the chemical control of *Liriomyza* spp. as a pest of tomatoes (probably *L. sativae*) and *L. sativae* as a pest of melons (as *L. subpusilla* Frost). Wilcox and Howland (1952) reported on the control of *Liriomyza* spp. (probably *L. sativae*) on tomatoes in southern California.

In 1957, Frick synonymized *Agromyza (Liriomyza) pusilla* (Meigen), *Agromyza (Liriomyza) subpusilla* Frost and *Liriomyza subpusilla* (Frost) with his new species *L. munda*. Spencer (1973) synonymized *L. munda* Frick with *L. sativae* Blanchard, the vegetable leafminer (Sutherland, 1978).

Frick (1957) discussed a new combination within the species *L. pictella* (Thomson) and subsequently identified the "melon leafminer" discussed by Oatman and Michelbacher (1958, 1959) and Oatman (1959a, 1959b, 1960a, 1960b, 1961). The present status of *L. pictella* in these studies is unclear and as indicated by Oatman (1961) may be a sibling species of *L. sativae* from sympatric natural populations.

Shorey et al. (1962) and Shorey and Hall (1963) reported on the toxicities of insecticides to *Liriomyza* spp. (probably *L. sativae*) on poled tomatoes in southern California.

Jensen (1969) and Jensen and Koehler (1970) discussed the status of *L. sativae* (as *L. munda*) on alfalfa. In these papers the authors indicate that two species of leafminers occur on alfalfa, *L. munda* and *L. pictella*. It is interesting that they state that the papers published by Oatman dealt with *L. munda*, not *L. pictella*, but that in alfalfa both species were present. Spencer (1973) identified the *L. pictella* of Jensen (1969) and Jensen and Koehler (1970) as a new species, *L. trifoliarum* (discussed below).

In 1976, Oatman and Kennedy demonstrated that outbreaks of *L. sativae* on tomatoes could be caused by applications of methomyl. This was followed by the recent work of Johnson (1979) and Johnson et al. (1980a, 1980b, 1980c, 1980d) with *L. sativae* as a pest of tomatoes where the parasite complex, effect of pesticides, and sampling plans were examined. Also in 1979, Hoskinson completed a study on the spatial and temporal distribution of *L. sativae* on pole tomatoes in southern California. Even though researchers working with leafmining Diptera on tomatoes in southern California since 1976 have cited only one species, it is probable that mixed populations of *L. sativae* and *L. trifolii* were present. During 1980, *L. sativae* was reared

from tomato and squash grown in southern California. Selected chemicals were evaluated for control of *L. sativae* as a pest of summer squash (Sharma et al., 1980). They reported that several materials provided good control and significantly increased yields.

Liriomyza trifoliarum Spencer

Liriomyza trifoliarum is Nearctic in distribution and has a rather narrow host range compared to the other economically important *Liriomyza* spp. in California. This leafminer has been cited as a pest of alfalfa in California (as *Liriomyza pictella* Thomson) (Jensen, 1969; Jensen and Koehler, 1970). Damage to alfalfa was caused by the tendency of mined leaflets to drop from the plant before or during harvest. This species was not collected during 1980.

Liriomyza trifolii (Burgess)

This species is Nearctic and Neotropical in distribution and enjoys a wide host range. Frick (1959) described specimens from California, Oregon and Washington as *L. trifolii*. Those from the latter state were described as new species by Spencer (1965) and the flies from California and Oregon were misidentifications. The true *L. trifolii* is a recent introduction into California (1975 or 1976) probably originating on chrysanthemum cuttings from Florida. This species was reared from chrysanthemums, verbena, cineraria, calendula, gypsophila, gerbera, snapdragon, sugar beans, tomato and celery in southern California during 1980. Bivins and McCloskey (1978) discussed chemical control of this species and Oetting et al. (1981) examined chrysanthemum varietal susceptibility to this leafminer species. *Liriomyza trifolii* is currently a very serious pest of chrysanthemums and is becoming more important as a pest of tomato and celery.

Discussion

The probable specific determinations of *Liriomyza* spp. in California were made on the assumption that there are five economically important species in California. The actual flies worked with by these researchers were not examined. Identifications were made using Spencer (1973) and Frick (1951, 1957, 1958, 1964) and by examining how each researcher viewed the identifications of flies from previous related work.

True polyphagy in the Agromyzidae is rare (Spencer, 1964) with only 10 polyphagous species recorded throughout the world (Spencer, 1977). It is probable that few, if any, further dominant and widespread polyphagous species will be found. California is in the unenviable position of having at least four polyphagous *Liriomyza* species. However, as stated by Spencer (1973) and demonstrated by Oatman (1961) the process of speciation among the polyphagous Agromyzidae is probably being reversed and further spe-

ciation can be expected. Thus, flies identified as the same species from different parts of California may not necessarily exhibit similar characteristics, even though they may be from the same host.

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Literature Cited

- Bivens, J. L., and W. McCloskey. 1978. New compound effective against leafminer fly on greenhouse chrysanthemums—Progress report. Flower and Nursery Report. Coop. Ext., Univ. Calif. Fall:1–2.
- Elmore, J. C., and C. A. Ranney. 1954. Injury to pepper plants by the pea leafminer. *J. Econ. Entomol.*, 47:357–358.
- Frick, K. E. 1951. *Liriomyza langei*, a new species of leafminer of economic importance in California. *Pan-Pac. Entomol.*, 27:81–88.
- . 1957. Nearctic species in the *Liriomyza pusilla* complex. No. 2. *L. munda* and two other species attacking crops in California. *Pan-Pac. Entomol.*, 33:59–70.
- . 1958. *Liriomyza dianthi* n. sp., a new pest of carnations in California. *Proc. Entomol. Soc. Wash.*, 60:1–5.
- . 1959. Synopsis of the species of agromyzid leaf miners described from North America. *Proc. U.S. Nat. Mus.*, 108:347–465.
- . 1964. *Liriomyza dianthi*, a new synonym of *L. langei* Frick (Diptera: Agromyzidae). *Pan-Pac. Entomol.*, 40:11–12.
- Hoskinson, S. E. 1979. Spatial and temporal distribution of *L. sativae* Blanchard (Diptera: Agromyzidae) on fall tomatoes, with implications in pest management. M.S. Thesis, San Diego State University, 82 pp.
- Jefferson, R. N., and C. O. Eads. 1949. Control of leaf miners on field-grown asters. *Univ. Calif. (Los Angeles) News Letter* No. 41.
- , and ———. 1952. Control of leaf miners and other insect pests of aster. *J. Econ. Entomol.*, 45:476–481.
- , and R. J. Pence. 1948. Preliminary experiments on the control of the leafminer *Liriomyza flaveola* on asters. *J. Econ. Entomol.*, 41:653–654.
- Jensen, G. L. 1969. Investigations of the economic importance of certain *Liriomyza* species on alfalfa in north and central California (Diptera: Agromyzidae). Thesis, University of California, Berkeley, 125 pp.
- , and C. S. Koehler. 1970. Seasonal and distributional abundance and parasites of leaf miners of alfalfa in California. *J. Econ. Entomol.*, 63:1623–1628.
- Johnson, M. W. 1979. Insect pest management strategies for control of *Liriomyza sativae* Blanchard (Diptera: Agromyzidae) on pole tomatoes in southern California. Dissertation, University of California, Riverside, 126 pp.
- , E. R. Oatman, and J. A. Wyman. 1980a. Effects of insecticides on populations of the vegetable leafminer and associated parasites on summer pole tomatoes. *J. Econ. Entomol.*, 73:61–66.
- , ———, and ———. 1980b. Effects of insecticides on populations of the vegetable leafminer and associated parasites on fall pole tomatoes. *J. Econ. Entomol.*, 73:67–71.

- , ———, and ———. 1980c. Natural control of *Liriomyza sativae* (Dip.: Agromyzidae) in pole tomatoes in southern California. *Entomophaga*, 25:193–198.
- , ———, ———, and R. A. Van Steenwyk. 1980d. A technique for monitoring *Liriomyza sativae* in fresh market tomatoes. *J. Econ. Entomol.*, 73:552–555.
- Lange, W. H., Jr. 1945. Investigations with DDT in California, 1944. *Univ. Calif. Agr. Exp. Stn.* :18–22.
- . 1949. Notes on the occurrence of agromyzid flies during 1948, and a record of two unreported species in California. *Pan-Pac. Entomol.*, 25:91–92.
- , A. A. Grigarick, and E. C. Carlson. 1957. Serpentine leafminer damage. *Calif. Agr.*, 11:3–5.
- , and L. M. Smith. 1947. Control of a leafminer on peas. *J. Econ. Entomol.*, 40:496–499.
- Michelbacher, A. E., O. G. Bacon, and J. Underhill. 1953. Leaf miner on tomato, control by dieldrin. Studied for northern California conditions. *J. Econ. Entomol.*, 7:15.
- , W. W. Middlekauf, O. G. Bacon, and J. E. Swift. 1955. Controlling melon insects and spider mites. *Calif. Agr. Exp. Stn. Bull.*, 749:1–46.
- , ———, and L. C. Glover. 1951. Studies with aldrin and dieldrin against melon insects. *J. Econ. Entomol.*, 44:390–393.
- , ———, and ———. 1952. Aldrin, dieldrin and heptachlor to control California melon insects. *J. Econ. Entomol.*, 44:470–475.
- , ———, F. C. Lamb, and N. B. Akesson. 1949. Further investigations of control of tomato insects in northern California. *J. Econ. Entomol.*, 42:666–674.
- Oatman, E. R. 1959a. Host range studies of the melon leaf miner, *Liriomyza pictella* (Thomson) (Diptera: Agromyzidae). *Ann. Entomol. Soc. Am.*, 52:739–741.
- . 1959b. Natural control studies of the melon leaf miner, *Liriomyza pictella* (Thomson) (Diptera: Agromyzidae). *J. Econ. Entomol.*, 52:759–762.
- . 1960a. Intraspecific competition studies of the melon leaf miner, *Liriomyza pictella* (Thomson) (Diptera: Agromyzidae). *Ann. Entomol. Soc. Am.*, 53:130–131.
- . 1960b. Parasitism of the overwintering pupae of the melon leaf miner, *Liriomyza pictella*. *J. Econ. Entomol.*, 53:682.
- . 1961. Crossbreeding studies with two closely related species of *Liriomyza*. *Pan-Pac. Entomol.*, 37:53–57.
- , and G. G. Kennedy. 1976. Methomyl induced outbreak of *Liriomyza sativae* on tomato. *J. Econ. Entomol.*, 69:667–668.
- , and A. E. Michelbacher. 1958. The melon leaf miner *Liriomyza pictella* (Thomson) (Diptera: Agromyzidae). I. Life history studies. *Ann. Entomol. Soc. Am.*, 51:557–566.
- , and ———. 1959. The melon leaf miner, *Liriomyza pictella* (Thomson) (Diptera: Agromyzidae). II. Ecological studies. *Ann. Entomol. Soc. Am.*, 52:83–89.
- , and G. R. Platner. 1969. An ecological study of insect populations on cabbage in southern California. *Hilgardia*, 40:1–40.
- Oetting, R. D., F. S. Morishita, and A. L. Helmkamp. 1981. Susceptibility of selected chrysanthemum cultivars to leafminer damage. *Flower and Nursery Rep., Coop. Ext., Univ. Calif., Winter*, p. 5.
- Pritchard, E. A. 1957. New carnation pests. Bud mite and leaf miner found in California may cause serious problems. *Calif. Agr.*, 11:5.
- Sharma, R. K., A. Durazo, and K. S. Mayberry. 1980. Leafminer control increases summer squash yields. *Calif. Agr.*, 34:21–22.
- Shorey, H. H., and I. M. Hall. 1963. Toxicity of chemical and microbial insecticides to pest and beneficial insects on poled tomatoes. *J. Econ. Entomol.*, 56:813–817.
- , H. T. Reynolds, and L. D. Anderson. 1962. Effect of Zectran, Sevin, and other new carbamate insecticides upon insect populations found on vegetables and field crops in southern California. *J. Econ. Entomol.*, 55:5–11.

- Smith, L. M., and W. H. Lange, Jr. 1946. Investigations with DDT and other new insecticides—Experiments with DDT and lead arsenate for controlling the pea leafminer and other pea insects. Calif. Agr. Exp. Stn. Circ., 365:52–54.
- Spencer, K. A. 1964. The species-host relationship in the Agromyzidae as an aid to taxonomy. Int. Cong. Entomol. Proc., 12:101–102.
- . 1965. A clarification of the status of *Liriomyza trifolii* (Burgess) and some related species. Proc. Entomol. Soc. Wash., 67:32–40.
- . 1973. Agromyzidae (Diptera) of economic importance. Dr. W. Junk B. V., The Hague, Netherlands, 418 pp.
- . 1977. A revision of the Australian Agromyzidae. West. Aust. Mus. Special Pub., 8:21.
- Steyskal, G. C. 1973. The strange fate of the “serpentine leaf miner” (*Liriomyza* spp., Agromyzidae, Diptera). U.S.D.A. Coop. Econ. Ins. Rep., 23:735–736.
- Sutherland, D. W. S. 1978. Common names of insects and related organisms (1978 revision). Special Publication, Entomological Society of America, 132 pp.
- Tilden, J. W. 1950. Oviposition and behavior of *Liriomyza pusilla* (Meigen). Pan-Pac. Entomol., 26:119–121.
- Wilcox, J., and A. F. Howland. 1952. Control of dipterous leaf miner on tomatoes in California. J. Econ. Entomol., 45:634–639.
- . 1955. Control of the pea leaf miner in southern California. J. Econ. Entomol., 48:579–581.